Nuclear Weapons

Home Office and
Scottish Home and
Health Department

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EXTRACTS

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Preface

1. Information obtained from the study of the results of British and American trials of nuclear weapons of different types and power has rendered obsolete some of the information in the Manual of Civil Defence Vol I Pamphlet No I "Nuclear Weapons". This booklet reviews the effects of nuclear detonations in the light of this information and also presents the latest considerations on the control of radiological exposure. Chapter 10 on 'Hazards to Food, Water, Crops and Livestock' similarly incorporates current knowledge. The booklet is intended primarily for use by persons who are involved in home defence planning, but it may be of interest to others.
2. The booklet describes a wide range of nuclear weapon effects. In cross references in the text the first number denotes the chapter and the second the number of the paragraph in that chapter.

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1.10 The more familiar units of energy (eg the kilowatt hour) are too small to express the vast quantities of energy released in the detonation of a nuclear bomb. Two units are commonly used; the kiloton (KT) unit equivalent to 1,000 tons of TNT, and the megaton (MT) unit equivalent to the energy released by the detonation of 1,000,000 tons of TNT.

1.14 The temperature of the air in northern temperate latitudes falls gradually with increasing altitude and, at a height of about 35,000 to 40,000 ft, there is a region called the tropopause where it remains constant at about −60°C: above this is the stratosphere. The cloud produced by the detonation of a KT weapon, if it does reach the tropopause, will not penetrate far but will flatten out into the well-known mushroom shape.

1.26 To counter attacks from IRBMs and ICBMs within the time available between launching and impact, it is necessary to detect the weapon, to compute its ballistic path and to fire and detonate as far away as possible from the target a defensive missile which is close enough to its path to destroy it.

Personal protection from thermal radiation

5.10 To obtain protection from thermal radiation, one has only to move out of the direct path of the rays from the fireball and any kind of shade will suffice.

Fire protection and precautions

5.12 Primary fires in buildings would result from heat flash through windows and other openings igniting the contents. To reduce the risk, inflammable items should be placed as far as possible out of the direct path of any heat rays that might enter through windows or other openings. If windows and skylights are whitewashed or painted this would keep out about 80 per cent of the heat radiation.

5.13 Because buildings have a considerable shielding effect on one another in a closely built up area the windows of the upper floors are more important than those lower down.

5.14 Blast damage, the scattering of domestic fires, the rupture of gas pipes or short-circuiting of electrical wiring may start secondary fires. The risk of these fires would be reduced by extinguishing boilers and open-fires and by turning off gas and electricity at the mains.

5.16 In the last war fire storms were caused in the old city of Hamburg as a result of heavy incendiary attacks and at Hiroshima but not Nagasaki. A close study of these fire storms and of German cities in which fire storms did not occur revealed several interesting features. A fire storm occurred only in an area of several square miles, heavily built-up with buildings containing plenty of combustible material and where at least every other building in the area had been set alight by incendiary attack.

5.17 It is considered unlikely that an initial density of fires, equivalent to one in every other building, would be started by a nuclear explosion over a British city; studies have shown that due to shielding a much smaller proportion of buildings than this would be exposed to heat flash. Moreover, the buildings in the centres of most British cities are now of fire-resistant construction and more widely spaced than 30–40 years ago. Fire storms after nuclear attack are therefore unlikely in British cities but the possibility would be greatly reduced by the control of small initial and secondary fires.

Table 23 Approximate protective factors in ground floor refuge rooms of typical British housing with timber upper floors and with windows and external doors blocked

Types of housing	Protective factor
Bungalow	5–10
Detached two-storey	15
Semi-detached two-storey 11 inch cavity walls	25–30
Semi-detached two-storey 13½ inch brick walls	40
Terraced two-storey	45
Terraced back-to-back	60
Blocks of flats and offices (see paragraph 9.1) Lower floors	50–500
second floor and above (decreasing)	50–20

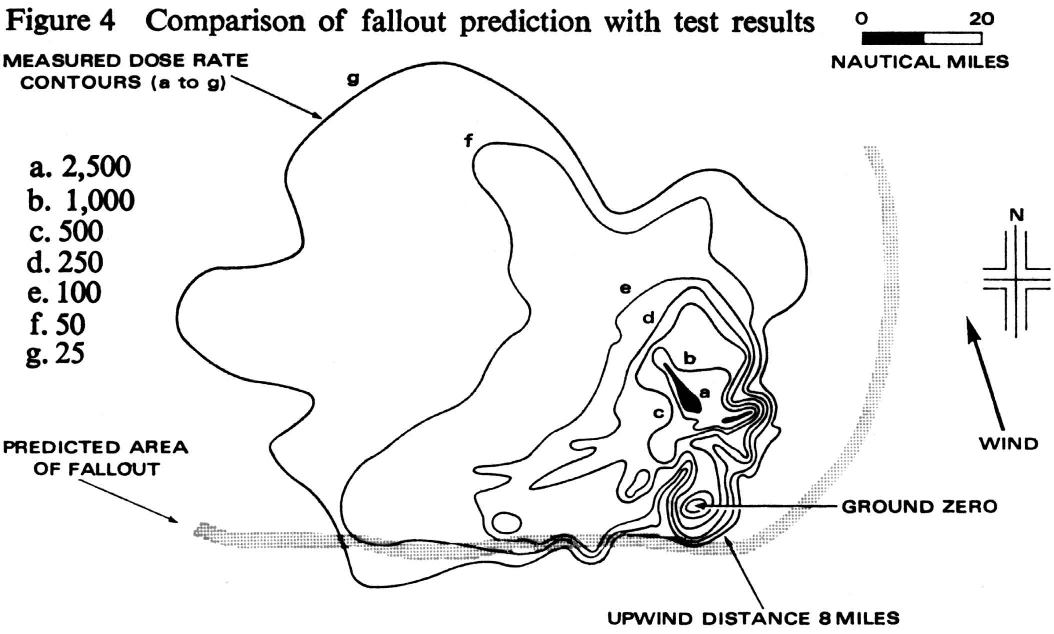
9.20 The amount of fallout retained in the United Kingdom on a clean dry roof with a slope of about 30° (about 1 in 2) or more would be insignificant. If the roof were damp, most of the fallout would be retained until it becomes dry. Rainfall, other than a very light drizzle, would wash fallout off the roof. Consequently the protective factors of prepared refuges in most British houses may be higher than the values given in Table 23.

Table 13 Downwind Contamination. Areas of contours for reference dose-rates at one hour after burst (DR1's) assuming 50% fission yield for ½ MT and larger weapons and 100% for KT weapons

Reference contour dose-rate rph at *one* hour after burst (DR1's) in rph	Areas in square miles for weapon power			
	20 KT	100 KT	½ MT	1 MT
3000	0.2	1.2	10	20
1000	1.3	6.4	45	90
300	5	25	200	300
100	16	82	450	900
30	50	250	1,100	2,000
10	200	1,000	2,250	4,500

8.18 The time between the first arrival of fallout and maximum dose-rate may be anything between one quarter and 4 times that between detonation and the first arrival of fallout: it may be several hours after the maximum dose-rate is reached before fallout ceases.

Figure 4 Comparison of fallout prediction with test results



Basements and trenches

9.21 A substantial increase in protection is obtained in cellars or basements, or in trenches under the floor. For example a trench under a detached two-storied house could give a PF of about 100 and a basement of between 50 and 100, if all the floor was 5 feet below ground level.

9.22 A properly constructed slit trench in the open with 3 feet of earth cover would have a protective factor of 200 or more.

Protection afforded by vehicles

9.23 The protective factors of various types of road transport are very low compared with buildings and would be about 1.5 or slightly more depending upon the size and weight of the vehicle, the height of the seating above ground and on the number of passengers. In passenger trains the protective factor would be equally low, between 3 and 5 depending upon the amount of fallout retained on the coach roof. In ships and boats away from land, protection would be significantly greater owing to the sinking of particles of fallout in water.

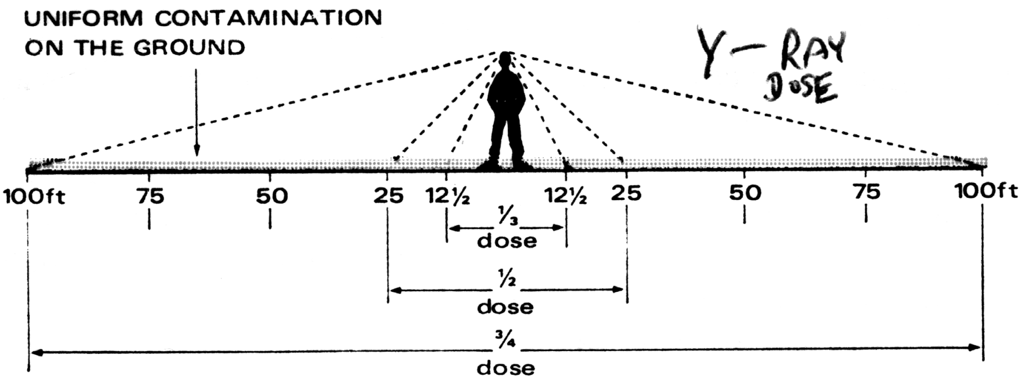


Figure 3 Total dose from fallout—contribution from different distances

Relation between the external radiation hazard and the hazard from breathing or swallowing fallout particles

8.10 When fallout is coming down, or in an area already covered by radioactive fallout, the gamma radiation hazard from the surroundings would be far greater than the hazard from any radioactive dust which might be inhaled or swallowed.

3.4 About 200 isotopes, or different radioactive species, of the atoms of about 35 elements are released in a nuclear fission detonation and their half-lives vary from a fraction of a second to thousands of years. The rate of decay of the mixed fission products is rapid at first but it slows down in time as the shorter-lived isotopes disappear.

$R_t = R_1 . t^{-1 \cdot 2}$, where R_1 is the nominal dose-rate in rph at 1 hour after burst and R_t is the dose-rate at any later time t hours

Table 2

Time after burst	Dose-rate rph
1 hour	100
1¾ hours	50
7 hours	10
2 days (49 hours)	1
2 weeks	0.1
14 weeks	0.01

Entry of fission products into the human body

10.1 Over and above the main contact hazard described in paragraph 8.6 *et seq*, additional hazards to humans might arise from the consumption of:

a. products derived from animals grazing contaminated pastures or from fish caught in contaminated waters;

b. growing crops superficially contaminated by fallout;

c. superficially contaminated stored food or food in transit; and

d. contaminated water.

Radioactive strontium and iodine

2.17 In order to dispose of some of the myths surrounding radiation hazards, mention is made here of Strontium 90 and related isotopes. The radioactive strontium isotopes found among the fission products of a nuclear detonation are Strontium 89 which has a half-life (see paragraph 3.3) of about 51 days and Strontium 90 which has a half-life of about 28 years. Both of these emit beta particles (see paragraph 6, Appendix I) but no gamma radiation; some Sr90 may accumulate and persist in growing bone for many years, but the beta particles have a very short range and only affect the bone marrow, without reaching the germ cells. Radioactive strontium is therefore not a genetic hazard; nor is radioactive iodine, which tends to accumulate in the thyroid gland in the neck. The predominant form of radioactive iodine has a relatively short half-life of about eight days and could be a hazard, primarily to infants and young children with small thyroid glands.

Eggs, milk and fish

10.19 Eggs, derived from exposed but surviving animals, would not contain enough radioactivity to present a serious ingestion hazard. Most fission products are eliminated via the egg shells. Free-range hens would obviously be at greater risk of dying than those kept under cover. Thyroid damage from the consumption of eggs from apparently healthy poultry can be discounted.

10.20 The main ingestion hazard in the immediate post-attack period is presented by the consumption of milk and milk products, obtained from dairy cattle which have grazed contaminated pastures. Owing to the concentration of radioactive iodine in the animal thyroid and its rapid transfer into the milk, the radioiodine level would reach a maximum after about two to three days. The risk to children would be avoided by the use for, say, three weeks of milk powder, milk substitutes or milk from cows kept under cover and fed on uncontaminated fodder. Contaminated milk could be used to prepare products such as cheese or butter, where normal storage prior to consumption would allow the decay of the short-life iodine isotopes

Fallout on crops

10.16 Radioactive fallout will contaminate large areas of crops and pasture.

Cereals—Wheat, barley etc. Fallout particles lodge mainly in the outer part of the ear. The threshing process and rejection of the husk fraction after milling would remove up to 90 per cent of the original contamination. — Butler R2 test date !!!

Root crops—Potatoes, beet etc. The direct contamination hazard to the root is negligible. Rejection of the contaminated tops, washing and/or peeling of the root would give almost complete decontamination.

Surface crops, open leaf—Cabbage, lettuce etc. The rough leaf and open structure of this class of vegetables could result in high retention of fallout particles. These vegetables, which have a low energy value, could be used after rejecting the outer leaves and washing the remainder.

Surface crops, legumes—Peas, beans etc. The pod structure of this class of vegetables provides a natural protective cover, and pod removal ensures almost complete decontamination.

Hard fruits—Apples, pears etc. The acts of washing and peeling provide almost 100 per cent decontamination.

Soft fruits—Plums, blackberries etc. This relatively minor source of food would be difficult to decontaminate.

Greenhouse vegetables—Tomatoes, lettuce etc. Contamination also occurs if the greenhouses are damaged. If the food inside is salvageable, washing in the the case of tomatoes and outer leaf removal and washing of the lettuce ensure adequate decontamination.

Table 28 Conversion of relevant British and non-SI units to equivalent values in SI units

1 micron (micrometre)	one thousandth of 1 millimetre one millionth of 1 metre
1 inch	25.4 millimetres
1 foot	0.305 metres
1 mile	1.609 kilometres
1 square foot	0.093 square metres
1 square mile	2.59 square kilometres
1 foot per second	0.3049 metres/sec
1 mile/h (mph)	1.609 kilometres/h
1 gallon	4.546 dm^3
1 lb force (0.4536 kg force)	4.448 newtons
1 lb per square inch (1 psi)	6895 newtons/sq metre
1 psf	47.9 newtons/sq metre
1 calorie (Btu=252 cal.)	4.187 joules

12. Published information suggests that an unconfined sphere of U-235 metal of about 6½ in. diameter and weighing about 48 kilogrammes would be a critical amount: this would be reduced to about 4½ in. diameter (16 kg) for a U-235 sphere enclosed in a heavy tamper.